

Patent Premium in Countries with Weak Intellectual Property Rights Protection

Can Huang^a and Zhe Qu^b

^a *United Nations University-MERIT and Maastricht University, Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands*

^b *School of Management, Fudan University, 670 Guoshun Road, Shanghai, P.R. China*

An Extended Proposal

Abstract

Given the high opportunity cost of patenting in countries with weak intellectual property right (IPR) protection, it is paradoxical to observe an increase of patenting activities by multinational corporations and indigenous companies in some of those countries in the past decade. We undertake a large-scale firm-level study in the context of China (an emerging economy with weak IPR protection) to investigate the cost and benefit associated with patenting activities there. We employ the method of propensity score matching to investigate whether the total factor productivity of multinational corporations and indigenous companies grew faster after they applied for patents in China than had they not done so, and also compare the increase of total factor productivity at various levels of market competition.

Keywords: patent premium, intellectual property rights, emerging economies, multinational corporations, competition, total factor productivity

Mailing address and full contact details of the corresponding author:

Dr. Can Huang
United Nations University-MERIT and Maastricht University
Keizer Karelplein 19
6211 TC Maastricht
The Netherlands
Tel: +31 433884455
Fax: + 31 433884499
Email: can.huang@maastrichtuniversity.nl

Email address of Dr. Zhe Qu
quz@fudan.edu.cn

1. Introduction

Over the last three decades, belief in the importance of patents has contributed to the strengthening of patent protection and subsequently patenting boom in many countries (Kortum and Lerner, 1999; Hu and Jefferson, 2009). However, as Arora et al. (2008) argued, the pro-patent changes in legislation and business strategies proceed with limited empirical evidence on the impact of patent protection on industrial innovation. It is well known that patenting is not the only method to appropriate returns on investment on innovation. In many industries firms use secrecy or lead time rather than patent as appropriation methods (Levin et al., 1987; Arundel and Kabla, 1998). To quantify the effect of patent on innovation in the US industries, Arora et al. (2008) employed a structural model to estimate the proportional increment in the value of innovation due to patent protection (patent premium). They found that firms that patented innovations are expected to earn almost 50 percent more on average than if they had not patented those innovations. However, they also concluded that in most industries the unconditional patent premium, which is the average premium of all innovations (including those not patented), does not compensate the opportunity cost of patenting due to information disclosure, likelihood of inventing around and the cost of enforcement etc.

As the world economy became increasingly integrated, Multinational Corporations (MNCs) are strongly motivated to move their research and development (R&D) activities to emerging economies as a means of lowering R&D costs and operating close to their markets.¹ This trend dovetails with the growth of indigenous R&D activities in the emerging economies. As a result, more and more inventive activities take place in emerging economies, beyond the traditionally innovative triadic regions of Europe, Japan, and the United States. A remarkable characteristic of the emerging economies is that in these countries the intellectual property right (IPR) protection is weak. Thus the opportunity cost of patenting there may be much higher than that in Europe, Japan and the United States and patent premium in the emerging economies can be fairly modest. This reasoning is confirmed by Keupp et al. (2012). Keupp et al. conducted an in-depth case study on the motivations of 11 foreign firms for patenting in China. They reported that some firms encountered serious infringements and sometimes the infringements can occur on a weekly basis. Nevertheless, it seems to be paradoxical that despite the weak IPR protection and possibly low patent premium in China, patenting activities have surged in China in the last ten years or so. In 2011 China surpassed the US and became the country which received the most invention patent applications in the world. Both foreign firms and domestic firms contributed to this trend. Data shows that the number of foreign patent applications in China grew at averagely 15 percent annually during 2000–2011. To our best knowledge, there has not been any large-scale firm-level study that investigates the cost and benefit of patenting activities in emerging economies with weak IPR protection (for example, China).

Standard patenting theory holds that firms apply for patents to prevent others from making, using, or selling the patented products or technologies. However, reality is more complex than the

¹ According to the International Monetary Fund's definition, emerging economies include Argentina, Brazil, Bulgaria, Chile, China, Colombia, Hungary, India, Indonesia, Jordan, Kazakhstan, Kenya, Latvia, Lithuania, Malaysia, Mexico, Morocco, Nigeria, Pakistan, Peru, Philippines, Poland, Romania, Russia, Saudi Arabia, South Africa, Thailand, Turkey and Ukraine.

theory suggests. There are many other reasons for which firms file for patents. For instance, many companies apply for patents for purely defensive purposes, hoping to build up their patent portfolios to prevent others from suing them for infringement (Ziedonis, 2004). They also use patents as bargaining chips to reach cross-licensing agreements with their competitors, thereby cutting through patent application thickets (Shapiro, 2001). Other companies, particularly start-ups, file for patents to enhance their prospects for attracting investors, being acquired, or issuing initial public offerings (Graham and Sichelman, 2008; Hsu and Ziedonis, forthcoming). Patent premium is thus likely to be affected by the purposes of patenting activities. In the context of emerging economies, local rivals' patents may negatively impact productivity of a MNC, particularly when the local rivals' patents overlap with the MNC's in scope. However, local rivals' preemptive or defensive patenting might stimulate the MNC's own patenting activities which may lead to productivity gain of MNCs. The effect of competition on MNC's patent premium is thus theoretically ambiguous. That said, we know little about the relationship between patent premium and strategic interaction between MNCs and competing local firms in countries with weak IPR protection. Holding the same view, Arora et al. (2008) admitted that ignoring strategic interaction between rivals is one of the limitations of their study on patent premium of the US firms.

This study aims to contribute to the abovementioned streams of literature by quantifying patent premium of MNCs and local firms in countries with weak IPR protection. In particular, we investigate the relationship between patent premium and competition among MNCs and local firms. We constructed a novel firm-patent dataset by linking the Database of Annual Survey of Industrial Enterprises (maintained by the National Bureau of Statistics of China) and the Database of China Patent Abstract (maintained by the State Intellectual Property Right of China, SIPO). We employed the econometric technique of propensity score matching in data analysis.

2. Theoretical framework and hypotheses

2.1 Resource-based view, competitive advantage theory and patent as unique resource

We draw on resource-based view and competitive advantage theory to explain the patent premium that MNCs and local firms can obtain in countries with weak IPR protection. The resource-based view considers firms as bundles of heterogeneous resources that include tangible and intangible assets, operational processes, and products (Amit and Schoemaker, 1993). Competitive advantage is defined as the strategic advantage a firm has over its rivals within its competitive industry. A firm can achieve superior performance and build up its competitive advantage through its unique resources. Rival firms can erode a focal firm's competitive advantage if they possess similar resources that pose threat to the focal firm. Sustainability of the focal firm's competitive advantage will therefore be determined by whether rival firms are able to imitate such key resources and whether the focal firm can create barriers to such imitation.

Because of the monopoly nature of patent, it can be used by firms as a key resource to achieve competitive advantage (Teece, 1986, Hall, 1992). However, rival firms can invent around a focal firm's patents. In this case, the uniqueness of resource reflected by the focal firm's patents is compromised. In addition, in so-called complex product industries such as electronics and semiconductor, a new and commercializable product or process is comprised of numerous separately

patentable elements; hence rival firms may hold patents that are necessary for the focal firm to produce and sell its products. Therefore, firms have to make strategic decisions in the course of patenting as returns on the investment in patents (patent premium) are not only determined by the value of the underlying innovations, but also by the extent to which the patents can render competitive advantage to the firms.

The strategies that a firm uses to create barriers to imitation are known as “isolating mechanisms”. Isolating mechanisms are associated with corporate culture, managerial capabilities, information asymmetries and intellectual property rights such as patents (Lippman and Rumelt, 1982; Dierickx and Cool, 1989; Reed and DeFillippi, 1990). In addition to employing isolating mechanisms, a firm also needs to modify and develop resources in order to excel in future market competition as the requirements for adequate resources are constantly changing in a volatile market environment (Chaharbaghi and Lynch, 1999). Moreover, a competitor can enter a market with a powerful resource that may invalidate the incumbent firm’s competitive advantage (Barney, 1986). In response, incumbent firms can strengthen their existing resources and develop new resources to cope with the competition brought by entrants. Because patent has both entry-detering and entry-promoting effects, incumbent firms can harvest greater patent premium by patenting more aggressively than before. Entrants can also patent actively to build up their competitive advantage against the monopoly power that incumbent firms obtain through their patent portfolios (Cockburn and MacGarvie, 2011).

2.2 Hypotheses

Emerging economies, compared to mature economies, are characterized by a high-velocity environment where market growth is rapid but the positions of market players change constantly (Hoskisson et al., 2000). In addition, emerging economies are typically with weak IPR protection (Zhao, 2006). Contrary to common understanding, the toughest competitors in emerging economies are often local firms, which can be more effective than their foreign counterparts in developing strategies that suit the markets (Walters and Samiee, 2003). Local firms may know better than MNCs with regard to whether patenting can create value for their respective innovations in a market environment where IPR protection is weak. However, MNCs are typically equipped with superior technological capability. To sustain their superior performance, MNCs can protect their superior technological knowledge through patents which prevent their local competitors from imitation. In this study, we use total factor productivity (TFP) to measure firm performance. We consider a firm obtains positive patent premium if it achieves faster TFP growth through patenting than had it not applied for patents, *ceteris paribus*. With these definitions we develop the Hypothesis 1a and 1b:

H1a: *MNCs in countries with weak IPR protection obtains positive patent premium.*

H1b: *Local firms in countries with weak IPR protection obtains positive patent premium.*

In emerging economies, MNCs face fierce competition from local firms. Local firms can take advantage of technological spillovers from MNCs to improve their own technological capabilities, aiming to offer high value-added products or services. Local firms may also imitate MNCs’ products and services to launch their new ones with incremental innovations. Local firms’ patenting activities can challenge MNCs’ leading position and reduce the value of MNCs’

patents if local firms' patents and MNCs' overlap in scope. Local firms' patenting activities will in one hand reduce MNCs' patent premium by crowding in the technological or product space in which MNCs operate and exacerbating patent thickets that compromise MNCs' freedom of design or manufacture. On the other hand, local firms' patenting activities will stir MNCs to seek more patents than otherwise, which would enhance patent premium of MNCs. It thus follows that the premium of MNC's patenting activities is contingent on the patenting activities of competing local firms and vice versa. This leads to Hypothesis 2a and 2b:

H2a: The patent premium of MNCs in countries with weak IPR protection increases with the intensity of competition from local firms.

H2b: The patent premium of local firms in countries with weak IPR protection increases with the intensity of competition from MNCs.

3. Empirical design

3.1 Data

To investigate the above hypotheses, we constructed a novel firm-patent dataset by linking two databases together. One is China's National Bureau of Statistics' Annual Survey of Industrial Enterprises (ASIE), which is a census of all non-state owned firms with more than RMB five million in revenue and all state-owned firms in China. There are 146,251, 147,413, 155,935, 165,988, 179,749, 255,266, 269,233, 301,960, 336,732 manufacturing firms in the dataset for the years 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006 and 2007, respectively. The dataset contains more than 50 firm-level statistical indicators, including input, output, R&D expenditure, capital composition, employment, geographical location, the industry in which a firm operates (at the four-digit level), ownership status, and assets and liabilities. The other database is the China Patent Abstract Database (CPAD). It includes over four million patent applications submitted by domestic and foreign applicants to the Chinese State Intellectual Property Office (SIPO) from 1985 when the patent system in China was established till 2009. The information provided in the database on each patent includes patent application and publication number, application and publication date, patent number, title, International Patent Classification class, abstract, claims, legal status, and so on.

From the ASIE we selected all the 8,585 firms in the following two two-digit manufacturing sectors for this study: Electronics and Telecommunication (ICT) and Precision Instruments and Office Machinery. We hired nine research assistants to manually search the names of the 8,585 firms in the CPAD. After the cleaning, we obtained the final patent dataset including 23,074 patents from 1,807 firms.

To our best knowledge, only Eberhardt et al. (2012) have made similar efforts to construct a firm-patent database for China. However, our method achieves more comprehensive coverage and accurate linkage between firms and patents than Eberhardt et al.'s method does. This is because, first of all, we linked the ASIE and the CPAD through firm names in Chinese, but Eberhardt et al. linked the ASIE in Chinese and the European Patent Office's PATSTAT database in English through a bridging database Oriana of Bureau Van Dijk. As Eberhardt et al. documented, the Chinese firm names in the PATSTAT were either Chinese characters, or pinyin

transcription into the Latin alphabet, or a translation of the Chinese names into English, or any combination of the three. Our method improves accuracy in the sense that we avoided errors resulting from linking names in Chinese, Latin alphabet or English. Second, only 23,000 firms are included in the Oriana database, which are about one tenth of the total firms in the ASIE. The best efforts by Eberhardt et al. can only establish 10 percent of all possible linkages. Our method hence achieves much more comprehensive coverage than theirs.

3.2 Econometric framework

3.2.1 Calculation of productivity

We calculate the productivity of the MNCs and local firms through the semi-parametric method designed by Olley and Pakes (1996). Olley and Pakes' estimator (OP) modeled unobserved productivity as a function of observable investment and capital. In comparison to Ordinary Least Square (OLS) estimator, the OP estimator has the following advantages. It allows controlling for the simultaneity bias when estimating production functions, without having to rely on instruments. It also controls for potential selection bias in estimating production functions. The coefficients of the labor and material inputs obtained by the OP estimator are smaller than those of the OLS, but the coefficient of capital is greater.

With the coefficients of the production function in hand, we can recover a Total Factor Productivity (TFP) measure ε_{it} of firm i in year t in the following way

$$(1) \varepsilon_{it} = y_{it} - b_l l_{it} - b_k k_{it},$$

where y, l, k denote the log of value added, labor and capital, respectively. The parameters b_l and b_k denote the OP estimators for labor and capital respectively.

3.2.2 Productivity dynamics and patenting activities

After obtaining the productivity ε_{it} , we rescale the time periods in such a way that a firm starts patenting at $t = 0$. Let ε_{it} be productivity of firm i at period t following entry in patenting activities at $t = 0$. The variable $Patent_i$ takes on the value one if a firm i starts to apply for patent. We follow the econometric program evaluation literature (De Loecker, 2007; Imbens and Wooldridge, 2009) to define the average effect of entry into patenting activity on productivity as

$$(2) E\{\varepsilon_{it}^1 - \varepsilon_{it}^0 | Patent_i = 1\} = E\{\varepsilon_{it}^1 | Patent_i = 1\} - E\{\varepsilon_{it}^0 | Patent_i = 1\},$$

where the superscript equals to 1 if the firm apply for patent and 0 otherwise. The crucial problem in this analysis is that ε_{it}^0 , the counterfactual or the productivity of a patenting firm had it not applied for patents, is not observable.

In order to identify this counterfactual group we assume that all differences between a focal patenting firm and the non-patenting firms can be captured by a vector of observables including the pre-patenting productivity of the firms. The intuition is to find a group that is as close as possible to the focal patenting firm in terms of its predicted probability to start applying for

patents. More formally, we apply the propensity score matching method as proposed by Rosenbaum and Rubin (1983). This boils down to estimating a probit model with a dependent variable equal to 1 if a firm starts applying for patents and zero otherwise on lagged observables including productivity.

The probability model of starting to apply for patents (the propensity score) can be represented as follows

$$(3) \Pr\{Patent_{i,0} = 1\} = \Phi(\varepsilon_{i,-1}, X_{i,-1}),$$

where $\Phi(\cdot)$ is the normal cumulative distribution function. The probability of starting to apply for patents is regressed on variables prior to the period $t = 0$ (we use subscript -1 to denote this period). The most important variable in estimating the propensity score is the productivity variable $\varepsilon_{i,-1}$. $X_{i,-1}$ are the other explanatory variables which account for the differences in productivity. They include size of the firm, R&D expenditure, ownership status, and year and industry dummies etc. The matching is based on the method of the nearest neighbor, which selects the non-patenting firms which have a propensity score p_i closest to that of the patenting firm.

Once we have this counterfactual (a set C of control firms) in hand we use a difference-in-differences methodology to assess the impact of applying for patents on productivity. The estimator of the patent premium β is calculated in the following way. Assume there are N firms that indeed applied for patents and a set C of control firms. ε_{it}^1 and ε_{jt}^0 are the estimated productivity of the firms indeed applying for patents and the controls, respectively. Denote $C(i)$ as the set of control units matched to the firm i with a propensity score of p_i . The number of control firms that are matched with the firm i is denoted as N_i^0 and the weight $w_{ij} = \frac{1}{N_i^0}$ if $j \in C(i)$ and zero otherwise. The estimator β at every year t after the decision to start applying for patents is given by

$$(4) \beta = \frac{1}{N} \sum (\varepsilon_{it}^1 - \sum_{j \in C(i)} w_{ij} \varepsilon_{jt}^0)$$

In short, we estimate the productivity premium of firms that started applying for patents at each year t compared with a weighted average of productivity of a control group based on nearest neighbor matching at every year t . To test H1, we implement the above analysis separately on the MNCs and local firms.

3.2.3 Productivity dynamics, patenting activities and competition

To test H2, we classify the firms into a strong-competition group and a weak-competition group. We then perform the analysis in Section 2.2.2 separately for these two groups and compare the results with the total sample.

The remaining issue would be which criteria we use to classify the firms into the two groups. Due to lack of citation information of the Chinese patents in the CPAD, we are not able to construct citation-based (patent thicket) indexes such as those outlined by Zeidonis (2004) and

von Graevenitz et al. (2011) to measure the extent to which the patents of the focal firm overlap with those of the rival firms. Instead, we construct an entry-based index in the following way. Using the information of patent class, we can identify which firms applied for patents in each of the six-digit patent classes and also pinpoint the six-digit patent classes where each firm applied for patents. We are thus able to spot an entrant firms i in a six-digit patent class r in year t . The entrant firm is defined as the firm that in the first time applied for patent in the class r . We can calculate the intensity of entry (number of entrant firms divided by number of incumbent firms) into the technologies (six-digit patent classes) in year t . Using a weighted share of the focal firm's patents in the six-digit patent classes, we can obtain an overall index to measure the competition that the focal firm faced in all its technological areas. Assuming that a high intensity of entry leads to high-level competition, we are able to classify firms into strong-competition and weak-competition groups.

Reference:

- Amit, R. and P. J. Schoemaker (1993). Strategic assets and organizational rent. *Strategic Management Journal* 14, pp. 33-46.
- Arora, A., Ceccagnoli, M. & Cohen, W. M. (2008) R&D and the patent premium. *International Journal of Industrial Organization*, 26, 5, 1153-1179.
- Arundel, A. & Kabla, I. (1998) What percentage of innovations are patented? Empirical estimates for European firms. *Research Policy*, 27, 2, 127-141.
- Barney, J.B. (1986). Organizational Culture: Can It be a Source of Sustained Competitive Advantage? *Academy of Management Review* 11(3), pp. 656–665.
- Chaharbaghi, K. and R. Lynch (1999). Sustainable competitive advantage: towards a dynamic resource-based strategy. *Management Decision* 37(1), pp.45 – 50.
- Cockburn, I. M. & Macgarvie, M. J. (2011) Entry and Patenting in the Software Industry. *Management Science*, 57, 5, 915-933.
- De Loecker, J. (2007) Do exports generate higher productivity? Evidence from Slovenia. *Journal of International Economics*, 73, 1, 69-98.
- Dierickx, I. and K. Cool (1989). Asset stock accumulation and sustainability of competitive advantage. *Management Science* 35, pp. 1504–1551.
- Eberhardt, M., Helmers, C. & Yu, Z. (2012) Is the Dragon Learning to Fly? The Chinese Patent Explosion at Home and Abroad. *CSAE Working Paper No. 2011-15*.
- Graham, S. J. & Sichelman, T. (2008) Why do start-ups patent? *Berkeley Technology Law Journal*, 23, 3, 1063-1097.
- Hall, R. (1992) The Strategic Analysis of Intangible Resources. *Strategic Management Journal*, 13, 2, 135-144.
- Hoskisson, R. E., E. Lorraine, C. M. Lau, and M. Wright (2000). Strategy in Emerging Economies. *Academy of Management Journal* 43 (3), pp. 249-267.
- Hsu, D. H. & Ziedonis, R. H. (2013) Resources as Dual Sources of Advantage: Implications for Valuing Entrepreneurial-firm Patents. *Strategic Management Journal*, forthcoming.
- Hu, A. G. & Jefferson, G. H. (2009) A great wall of patents: What is behind China's recent patent explosion? *Journal of Development Economics*, 90, 1, 57-68.
- Imbens, G. W. & Wooldridge, J. M. (2009) Recent Developments in the Econometrics of Program Evaluation. *Journal of Economic Literature*, 47, 1, 5-86.
- Keupp, M. M., Friesike, S. & Von Zedtwitz, M. (2012) How do foreign firms patent in emerging economies with weak appropriability regimes? Archetypes and motives. *Research Policy*, 41, 8, 1422-1439.
- Kortum, S. & Lerner, J. (1999) What is behind the recent surge in patenting? *Research Policy*, 28, 1, 1-22.
- Levin, R. C., Klevorick, A. K., Nelson, R. R., Winter, S. G., Gilbert, R. & Griliches, Z. (1987) Appropriating the Returns from Industrial Research and Development. *Brookings Papers on Economic Activity*, 1987, 3, 783-831.
- Lippman, S.A. and R.P. Rumelt (1982). Uncertain inimitability: an analysis of inter-firm differences in efficiency under competition. *Bell Journal of Economics* 13, pp. 418–453.
- Olley, G. S. & Pakes, A. (1996) The Dynamics of Productivity in the Telecommunications Equipment Industry. *Econometrica*, 64, 6, 1263-1297.
- Reed, R. and R. J. DeFillippi (1990). Causal ambiguity, barriers to imitation and sustainable competitive advantage. *Academy of Management Review* 15 (1), pp. 88–102.

- Rosenbaum, P. R. & Rubin, D. B. (1983) The central role of the propensity score in observational studies for causal effects. *Biometrika*, 70, 1, 41-55.
- Shapiro, C. (2001) Navigating the Patent Thickets: Cross Licenses, Patent Pools, and Standard Setting. IN JAFFE, A. B., LERNER, J. & STERN, S. (Eds.) *Innovation Policy and the Economy*, vol.1. Cambridge, Mass., The MIT Press.
- Teece, D. J. (1986) Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, 15, 6, 285-305.
- Von Graevenitz, G., Wagner, S. & Harhoff, D. (2011) How to measure patent thickets-A novel approach. *Economics Letters*, 111, 1, 6-9.
- Walters, P. G. P., and S. Samiee (2003). Marketing Strategy in Emerging Markets: The Case of China. *Journal of International Marketing* 11 (1), pp. 97-106.
- Zhao, M. (2006) Conducting R&D in Countries with Weak Intellectual Property Rights Protection. *Management Science*, 52, 8, 1185-1199.
- Ziedonis, R. H. (2004) Don't Fence Me In: Fragmented Markets for Technology and the Patent Acquisition Strategies of Firms. *Management Science*, 50, 6, 804-820.